Reducing Global Warming Pollution from Mobile Air Conditioning

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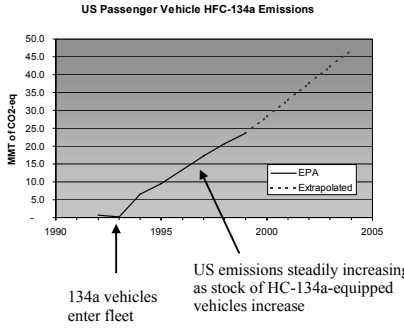
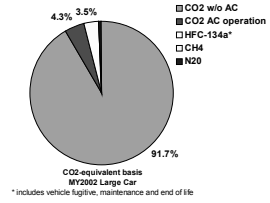
EMISSIONS OF HFC-134a RISING

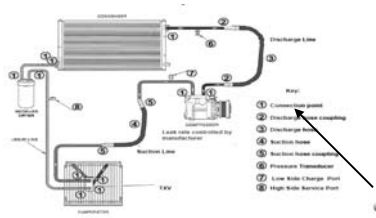


IMPORTANCE OF AC EMISSIONS

- 8% of total global warming pollution emissions on a per vehicle basis
- Largest source of non-CO_2 emissions
- Largest source of accessory related CO_2 emissions



SIMPLE SOLUTIONS AVAILABLE TO CONTROL AC SYSTEM LEAKAGE



Primary sources of leakage:
- **Compressor seals**
- **Connections x 10**
- **Hoses x 8**

Dual Seal x 10

DIRECT 134a EMISSIONS: METHODOLOGY

- Lifecycle emissions ("cradle to grave")
  - Manufacturing
  - Vehicle leakage
  - Servicing (not including DIY'ers)
  - End of life
- Emission factors
  - From previously published estimates, especially Europe
  - Adapted for larger US charge size
- Range of emission scenarios
  - Low, Mid, High
- Spreadsheet Model
  - Predicts recharge and recovery

MANUFACTURING, SERVICING, AND END OF LIFE

- Manufacturing
  - Small amount lost during filling of system, 1 to 5%
  - This study: 1, 2 and 6%
- Servicing
  - Recharge at 60% of original charge (60%)
  - Low: 6% of remaining charge = 55 g
  - Mid and High: 100 g
  - Results in 2-3 recharges over vehicle life
- End of life recovery
  - Unclear how much recovered due to low value
  - Assume 0, 25 and 50% recovery

VEHICLE LEAKAGE

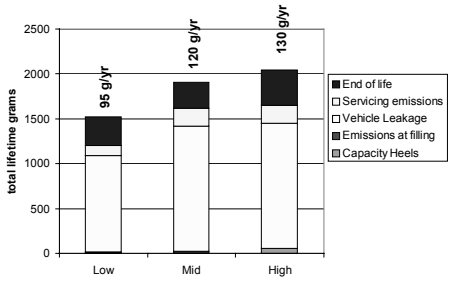
- Regular
  - Specifications appear to be around 25 to 40 g/yr but real-world should be higher
  - One European study found an average leak rate of 7.7% for US size charges (=70 g/yr)
  - This study: 50 to 70 g/yr
- Irregular (accidental releases)
  - European study estimated at 1.9% of initial charge (=17 g/yr for US-size charge)

SUMMARY KEY ASSUMPTIONS

Key Assumptions			
	Low	*Mid*	*High*
original charge, grams	910	910	910
Capacity Heels, % loss of orig charge	1%	2%	6%
Fugitive regular, g/yr	50	70	70
Accidental (irregular)	17	17	17
charge at refill, %	60%	60%	60%
charge at refill, g	546	546	546
Servicing emissions, g	54.6	100	100
One time servicing emissions	0	0	0
end of life recovery	50%	25%	0%

RESULTS LIFETIME DIRECT EMISSIONS

CARB estimate = 85 g/yr

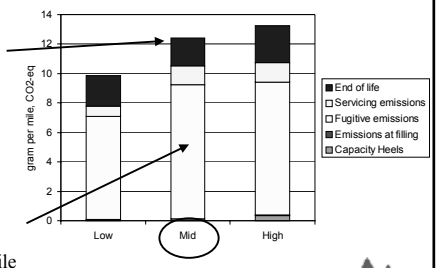


Assumes 16-year life, 200,000 miles

RESULTS CO_2 EQUIVALENT BASIS

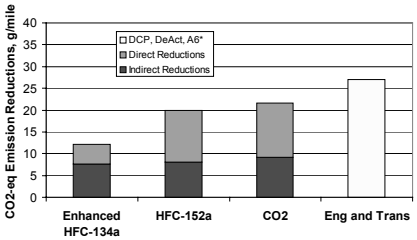
12 g/mile total emissions vs CARB estimate of 8.5 g/mile

9 g/mile vehicle leakage vs CARB estimate of 6 g/mile



Assumes 16-year life, 200,000 miles

AC CONTROL OPTIONS CAN REDUCE TOTAL EMISSIONS BY ABOUT 5%

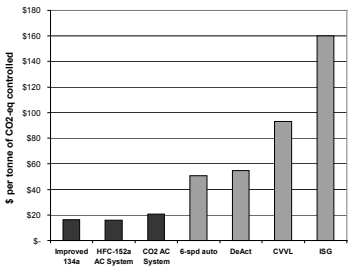


Assumes MY 2002 large car, 200K mile, 16-year life and $1.74/gallon

Based on NRDC estimates for direct (mid), CARB and NESCCAF data on indirect and for control cost and effectiveness

* DCP (dual cam phasing), DeAct (cylinder deactivation), A6 (automatic 6-speed transmission)

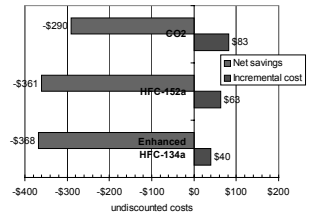
AC EMISSION CONTROLS ARE LOW COST COMPLIANCE OPTIONS



TECHNOLOGY DESCRIPTIONS:
- **6-spd auto: 6-speed automatic transmission**
- **DeAct: Cylinder Deactivation**
- **CVVL: Continuous Variable Valve Lift**
- **ISG: 42V Integrated Starter Generator**

AC REDUCTIONS ARE EXTREMELY COST-EFFECTIVE

- Incremental cost of $40 to $83 (NESCCAF 2004)
- Lifetime operating cost savings for fuel = $300-375 (undisc)
- Enhanced 134a and 152a reduces one servicing = $100
- Simple payback time of 2 to 4 years



Assumes MY 2002 large car, 200K mile, 16-year life and $1.74/gallon
NRDC calculations based on CARB and NESCCAF data

STATUS OF ENHANCED HFC-134a SYSTEMS

- Introduction in MY2006 timeframe possible since technology is well known
- Low leak components being developed by industry already to meet upcoming European regulations
- Variable displacement compressors already widespread in Europe
- New government/industry partnership announced at 2004 MAC Summit with goal of production vehicles by MY2006

COMMENTS ON CARB ANALYSIS

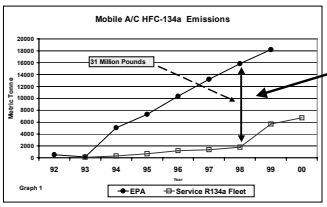
- Comparison
  - CARB direct emission estimates roughly consistent with NRDC "low" scenario
  - NRDC "mid" estimate is roughly 50% higher (8.5 vs 12 g/mile of CO2-eq)
- Differences
  - Initial charge, 950 g (CARB) vs. 910 g (MACS)
  - Higher vehicle leakage (70 g/yr)
  - Maintenance accidental releases, included in CARB 950g initial charge?
  - Percent charge at refill, 52% (CARB) vs. 60% (MACS), results in two charges per life, versus one charge in CARB analysis

COMMENTS CARB ANALYSIS

- Industry plans for servicing after 4 years (2-3 services over life), with longer term goal of 7 years (1 service over life)
- Low leak HFC-134a systems can eliminate one servicing
  - Reduces emissions by 50-100 gram over vehicle life
  - Additional $100 savings in servicing cost to consumers

REAL WORLD EMISSIONS GAP

How much is attributable to small cans?
Significant portion of 31 mill lb discrepancy between '98 service fleet R134a requirements and EPA R134a emissions



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Source: US EPA

COMMENTS ON CARB ANALYSIS

- Real world HFC-134a emissions "gap"
  - Well known emissions "gap" in EPA's top down and bottom-up inventory
  - Partially due to "do-it-yourselfers" with disposable cans and other uses, but gap is too large to be fully explained by these sources
- Implications
  - HFC-134a needs better "cradle-to-grave" controls which is outside the scope of AB1493
  - Alternative low-GWP refrigerants likely to have larger real-world benefit than estimated in CARB's analysis

CONCLUSIONS

- HFC-134a emissions are rapidly rising and are the largest source of non-CO_2 global warming pollution emissions from passenger vehicles
- Control technologies are rapidly being developed to meet forthcoming EC regulations
- Enhanced 134a are likely to be available by MY2006 and are a low cost global warming control option for manufacturers
- Control options save consumers money with simple payback time as low as 2 years

NRDC

CONCLUSIONS (cont.)

- CARB's assessment of direct and indirect emissions reductions is technically sound and a substantial contribution to our understanding of these emissions
- CARB's direct emission assessment is conservative, which will tend to underestimate the emission reductions and cost-effectiveness of control options

NRDC

MAC Industry: Part of the Solution or Part of the Problem?

NRDC